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Comparison of 3D-Computed Tomographic Angiography with Digital Subtraction Angiography for Detection of aneurysms among Spontaneous Subarachnoid Haemorrhagic Patients

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Abstract

Background: Detection of aneurysms among spontaneous subarachnoid haemorrhagic patients is a crucial issue for management. **Objectives:** The purpose of the present study was to compare the findings of 3D-computed tomographic angiography with digital subtraction angiography for detection of aneurysms among spontaneous subarachnoid haemorrhagic patients. **Methodology:** This comparative cross-sectional study was carried out in the Department of Neurosurgery and Cath Lab of Dhaka Medical College Hospital (DMCH), Dhaka, Bangladesh in collaboration with private diagnostic centre from September 2013 to February 2015 for a period of six (06) months. Adult patients diagnosed as a case of spontaneous SAH based on clinical features and confirmed by plain CT evidence of subarachnoid blood were included as study cases. Then both CTA and DSA were done in order to detect the cause of bleeding and make a treatment planning. All spiral CTAs were performed on a helical CT-Scan. Four vessels DSA were performed via a femoral approach in DMCH Cath Lab. **Result:** A total number of 37 patients presented with spontaneous subarachnoid haemorrhage were recruited for this study. CT Angiogram revealed aneurysm in 30(81.08%) patients. AVM found in 02(05.41%) patients and in 5(13.51%) patients CTA was negative for any abnormality. DSA of 37 patients revealed aneurysm in 32(86.49%) patients, AVM in 02(05.41%) patients and negative findings in 03(8.11%) patients. In CT Angiogram 25(67.57%) patients had single aneurysm. In DSA, 27(72.97%) patients had single aneurysm. The mean of the size of the aneurysms in CTA and DSA were in 6.70±3.04 mm and 6.75±2.94 mm ($p>0.05$). The mean of the neck width of the aneurysms in CTA and DSA were 3.86±2.06 mm and 3.41±1.67 mm ($p>0.05$). All aneurysm detected in CTA were also revealed in DSA. **Conclusion:** In conclusion the size, neck width and the location of aneurysm are detected in CTA and DSA equally without any statistical significant difference. *[Journal of National Institute of Neurosciences Bangladesh, July 2022;8(2):121-125]*

Keywords: Computed Tomographic Angiography; Digital Subtraction Angiography; aneurysms; Spontaneous Subarachnoid Haemorrhagic

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Introduction

Spontaneous Subarachnoid haemorrhage (SAH) is a condition characterized by acute leakage of blood into the subarachnoid spaces[1]. In patients presenting with spontaneous SAH, early diagnosis and detection of the underlying cause is considered critical in order to favour the prognosis. Early identification of an underlying ruptured aneurysm and adequate treatment may eliminate the risk of re-bleeding, which is a major mortality factor[2]. The therapeutic alternatives of a ruptured aneurysm include surgical clipping and endovascular coiling. Intra-arterial digital subtraction angiography (DSA) is considered the imaging gold standard for depicting the presence of an intracranial aneurysm[3-5]. However, DSA is an invasive imaging modality, with a relatively high cost and carries a small risk of neurological complications. DSA has currently been reported to cause transient or permanent neurological deficits when performed in 1 and 0.5% of patients, respectively[6]. Therefore, the utility of a non-invasive imaging modality that can detect the presence of intracranial aneurysms is of particular clinical significance.

The CTA has been used in the diagnosis and preoperative planning for patients presenting with aneurysmal subarachnoid haemorrhage[7]. It has been suggested that CTA has several advantages over MRA. The purpose of the present study was to compare the findings of 3D-computed tomographic angiography with digital subtraction angiography for detection of aneurysms among spontaneous subarachnoid haemorrhagic patients.

Methodology

Study Settings & Population: It was a comparative study. This present study was carried out in the Department of Neurosurgery and Cath Lab of DMCH in collaboration with private diagnostic centre. The study was done during the period of September 2013 to February 2015. Purposive and convenient sampling technique was used to collect the patients. Adult patients diagnosed as a case of spontaneous SAH based on clinical features and confirmed by plain CT evidence of subarachnoid blood were included as study population. Patients having current history of trauma, poor clinical grade and agitated patient, patient with renal insufficiency, known allergy to iodinated contrast agent and patients who were not willing participate in the study were excluded from this study.

Study Procedure: CTA and DSA were done in order to detect the cause of bleeding and make a treatment planning. All spiral CTAs were performed on a helical CT-scan. The characterization of an aneurysm includes number and size, location, morphology and direction, relation with adjacent arteries, visualization and measurement of the aneurysmal neck, presence of mural calcification and intraluminal thrombi. Four vessels DSA were performed via a femoral approach in DMCH Cath Lab. All DSAs was performed and interpreted by the interventional neurosurgical team. The team was blind about the CTA finding. CTA results were compared with DSA findings in all cases. Appropriate data were collected by using a preformed data sheet.

Statistical analysis: Statistical analysis was performed by using a commercially available statistical package (SPSS version 19; SPSS, Chicago, Ill). Quantitative variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequencies or percentages. Mean size of aneurysm and mean neck size depicted in CTA was compared with that of DSA using "t" test. When a p value is <0.05, the difference was considered statistically significant. In this study, DSA was considered a diagnostic standard for the evaluation of cerebral aneurysms. Approval from the Institutional review board of DMCH was taken before commencement of this study.

Results

A total number of 37 patients presented with spontaneous subarachnoid haemorrhage were recruited for this study after fulfilling the inclusion and exclusion criteria.

Table 1: Age Distribution of the Study Population

Age group	Frequency	Percent
41 to 50 years	06	16.22
51 to 60 years	12	32.43
61 to 72 years	19	51.35
Total	**37**	**100.00**
Mean ±SD	58.53(±7.54)	Range 41-72

The mean age of patients was 58.53(±7.54) years; majority age group was 60 to 72 years which was 51.35%. Minimum age was 41 years and maximum age was 72 years (Table 1).

Table 2: CTA and DSA Findings of the Study Patients

Variables	CTA Findings	DSA Findings
Aneurysm	30	32
AVM	2	2
Others	5	3
Total	**37**	**37**

CT Angiogram revealed aneurysm in 30(81.08%) patients. AVM found in 2(05.41%) patients and in 5(13.51%) patients CTA was negative for any abnormality. DSA of 37 patients revealed aneurysm in 32(86.49%) patients, AVM in 2(05.41%) patients and negative findings in 3(8.11%) patients. In DSA 2 new Aneurysm detected in 2 patients who were negative for any abnormality in CTA (Table 2).

Table 3: Number of Aneurysm in Each Patient in CTA and DSA

Number of Aneurysm	CTA Findings	DSA Findings
1	25	27
2	04	04
3	01	01
Total	**30**	**32**

In CT Angiogram out of 30 patients in whom aneurysm was detected, 25(67.57%) patients had single aneurysm, in 04(10.81%) patients double aneurysm found and in 1 patient there were 3 Aneurysm. Out of 32 patients in whom aneurysm was detected by DSA, 27(72.97%) patients had single aneurysm, in 04(10.81%) patients double aneurysm found and in 1(2.70%) patient there were 3 aneurysm (Table 3).

Table 4: Size distribution of Aneurysm Revealed in CTA and DSA

Size of Aneurysm	CTA	DSA	P value
2 to 5 mm	10	11	
6 to 9 mm	15	16	
≥10 mm	11	11	
Total	**36**	**38**	
Mean ±SD	6.70(±3.04)	6.75(±2.92)	0.94

Among the 36 aneurysm detected in CTA, 10(27.78%) were between 2 to 5 mm in size, 15(41.67%) were between 6-9 mm in size and 11(30.56%) were ≥10 mm in size. Mean of the size of the aneurysms is 6.70 mm with 3.04 mm standard deviation in a range of 2 to 12 mm. Table also shows that among the 38 aneurysm detected in DSA, 11(28.95%) were between 2 to 5 mm in size, 16(42.11%) were between 6 to 9 mm in size and 11(28.95%) were ≥10 mm in size. Mean of the size of the aneurysms is 6.75 mm with 2.94 mm standard deviation in a range of 2 to 12 mm. Above table shows there is no significant difference in mean size of aneurysm between CTA and DSA ($p>0.05$) (Table 4).

Among the 36 aneurysms detected in CTA, neck width of 24(66.7%) aneurysm were between 2 to 4 mm in size, 7(19.44%) aneurysm were between 5 to 7 mm in size and 5(13.89%) were ≥7 mm in size. Mean of the neck width of the aneurysms is 3.86 mm with 2.06 mm standard deviation in a range of 2 to 8 mm. Among the 38 aneurysms detected in DSA, neck width of 29 aneurysms were between 2 to 4 mm in size, 6 aneurysm were between 5 to 7 mm in size and 3 were ≥ 7 mm in size. Mean of the neck width of the aneurysms is 3.41 mm with 1.67 mm standard deviation in a range of 2 to 8 mm. There was no significant difference in mean neck width of aneurysm between CTA and DSA ($p>0.05$) (Table 5).

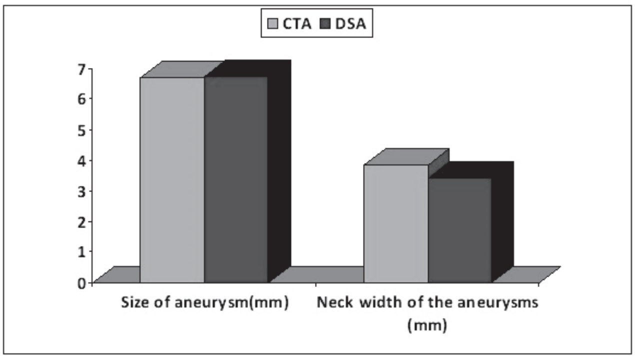

Figure I: Comparison between Mean Size of Aneurysm and Mean Neck Width Of The aneurysms in CTA and DSA

Table 6 showed location of aneurysm in CTA: 13(36.11%) were Acom aneurysm, 09(25%) were MC aneurysm, 5(13.89%) were arising from ICA, 8(22.22%) were Pcom aneurysm and 01(2.78%) was posterior circulation aneurysm. All aneurysm detected in CTA were also revealed in DSA. Moreover one Acom aneurysm and one posterior circulation aneurysm were detected in DSA but not in CTA. Thus in DSA 38 aneurysm were detected: 14(36.84%) were Acom aneurysm, 9(23.68%) were MC aneurysm, 5(13.16%) were arising from ICA, 8(21.05%) were Pcom aneurysm and 2(5.26%) was posterior circulation aneurysm.

Table 5: Maximum Neck Width of the Aneurysms Revealed in CT Angiogram and DSA

Neck width of the aneurysms	CTA	DSA	P value
2 to 4 mm	24	29	
5 to 7 mm	07	6	
≥7 mm	05	3	
Total	**36**	**38**	
Mean ±SD	3.86±2.06	3.41±1.67	0.30

Table 6: Location of Aneurysm Revealed in CT Angiogram and DSA

Location	CTA	DSA
ACOM	13	14
MC	09	09
ICA	05	05
PCOM	08	08
Posterior circulation	01	02

Discussion

Digital subtraction angiography (DSA) and Computed tomographic angiography (CTA) constitute the main methods for the study of these issues and each contributes to the diagnosis with different characteristics[8]. DSA has been considered the 'gold standard' method, against which the other imaging modalities for diagnosing intracranial aneurysms are compared. Although DSA presents a number of advantages large field of view, high spatial resolution, temporal imaging capabilities the fact that it is an invasive method cannot be underestimated[9]. Especially when handling a fragile group of patients suffering from SAH, the long examination time may affect negatively the quality of the images obtained. DSA may lead to ambiguous results due to its inability to project the aneurysm sufficiently.

Several factors contribute even technical to this like the location of the aneurysm in vessels bifurcation, regional complex vascular anatomy, vessels arising from the sac and the small size (less than 3 mm) of the aneurysmal sac, rotational limitations of the C-arm fluoroscopy, inadequate projections due to patient incorporation or projections out of the standard protocol[10-12]. In addition, mural calcifications, luminal thrombi, proximity to bony structures of the skull base and to the brain parenchyma, may constitute useful information for the treatment planning of some patients and cannot be obtained by DSA. These limitations reduce the diagnostic accuracy of DSA. Recent studies have shown that it can be improved when performed in combination with rotational angiography. In the study of Hochmuth and Spetzger[13], three-dimensional rotational angiography (3D-RA) revealed seven aneurysms not seen under conventional DSA and allowed more exact depiction of anatomic details important for the therapeutic planning. 3D-RA serves as an add-on technique to DSA providing precise measurements necessary for endovascular coiling[14].

CTA based on the three-dimensional algorithms for image post-processing, provides satisfactory sensitivity and additionally possesses the advantage of delineating more accurately the morphological features of the aneurysm than conventional DSA[11]. It is an easy to perform method, timesaving, tolerated well by patients with no contraindications to contrast material and provides an early diagnosis which assists in the decision making process. The limitations are well known from the literature and include the use of high doses of contrast material (100 to 120 ml), proper timing of scanning, low spatial resolution compared to DSA and therefore difficulty in identifying aneurysms smaller than 3 mm or arteries smaller than 1 mm. CTA cannot be repeated immediately afterwards in case of technical failure[9,13].

In the study period all patients of neurosurgery department of Dhaka Medical College Hospital was included in the study. Then both CTA and DSA were done in order to detect the cause of bleeding and make a treatment planning. This study group initially included 40 patients with spontaneous SAH. Three patients passed away immediately after CTA scan, thus excluded from the study. Thus there were a total of 37 patients that underwent both CTA and DSA and formed this study group. The mean age of patients was 58.53(±7.54) years; in a range of 41 to 72 years. In study of Karamessini et al[9] mean age was 49±15 years with age range of 15 to 76 years.

The commonest cause of spontaneous SAH is aneurysmal rapture in 70.0% to 85% of cases. Other causes include peri-mesencephalic haemorrhages with very good prognosis in 10% cases and other rare conditions such as bleeding of an AVM[15]. The data following CTA were in agreement with the above results, since we had 30/37 (81.08%) patients with SAH due to aneurysmal rapture, 2/37 (5.41%) patients with AVM and in 5/37 (13.51%) patients CTA was negative for any abnormality. Out of 30 patients in whom aneurysm was detected, 25(67.57%) patients had single aneurysm, in 04(10.81%) patients double aneurysm found and in 1 patient there were 3 aneurysm. Thus a total of 36 aneurysms were detected in 30 patients. Similar results was found by Kokkinis et al[1]. They observed 155/205 (75.6%) patients with SAH due to aneurysmal rapture, 35/205 (17%) patients with peri-mesencephalic haemorrhage and 15/205 (7.3%) patients with AVM. Among the 36 aneurysm, 10(27.78%) were between 2 to 5 mm in size, 15(41.67%) were between 6 to 9 mm in size and 11(30.56%) cases were ≥10 mm in size. Mean of the size of the aneurysms is 6.70 mm with 3.04 mm standard deviation in a range of 2 to 12 mm. Location of aneurysm in CTA are 13(36.1%) cases in ACOM aneurysm, 9(25.0%) cases in MC Aneurysm, 5(13.9%) cases arising from ICA, 8(22.2%) cases in PCOM aneurysm and 1(2.78%) cases in posterior circulation aneurysm.

All patients subsequently underwent DSA. All the positive finding revealed in CTA was also detected in DSA. In addition DSA identified 2 aneurysms in 2 patients who are negative for any abnormality in CTA. Thus out of 37 patients DSA revealed Aneurysm in

32(86.49%) patients, AVM in 02(05.41%) patients and negative findings in 03(8.11%) patients. Out of 32 patients in whom Aneurysm was detected by DSA, 27(85%) patients had single Aneurysm, in 04(12%) patients double Aneurysm found and in 1(3%) patient there were 3 Aneurysm. Thus 38 aneurysm was identified in DSA. In a similar study by Chen et al. (2009) a total of 92 aneurysms were identified in which 80 patients (93%) harbored one aneurysm and 6 patients (7%) had 2 aneurysms. One of the newly diagnosed aneurysm was in posterior circulation and size was 7 mm and the other one was an ICA aneurysm measuring 4 mm from neck to dome. Among the 38 Aneurysm, 11(28.95%) were between 2-5 mm in size, 16(42.11%) were between 6-9 mm in size and 11(28.95%) were ≥10 mm in size. Chen W et al. (2009) showed CTA for detecting aneurysms <4 mm, between 4 and 10 mm, and >10 mm was 96%, 98.1% and 100%, respectively, on a per-aneurysm basis. Mean of the size of the aneurysms is 6.75 mm with 2.94 mm standard deviation in a range of 2 to 12 mm. Karamessini et al9 shown that, 21.3% of the aneurysms were ≤3 mm, 29.8% 3–5 mm and 48.9% >5 mm, while the maximum diameter of the sac ranged between 2.5 and 18 mm and the mean size was 6.78 mm (SD=3.89). These findings are similar to them.

Among the 38 aneurysms, neck width of 29(76.32%) aneurysm were between 2-4 mm in size, 6(15.79%) aneurysm were between 5-7 mm in size and 03(7.89%) were ≥7 mm in size. Mean of the neck width of the aneurysms is 3.41 mm with 1.67 mm standard deviation in a range of 2 to 8 mm. The comparison between mean size of aneurysm and mean neck width of the aneurysms in CTA and DSA was done using Z test. There is no significant difference in mean size of aneurysm and mean neck width of the aneurysms between CTA and DSA ($p>0.05$).

Conclusion

In conclusion aneurysm due to AVM is detected by CTA and DSA without any difference. Same number of aneurysm is also detected both by CTA and DSA among spontaneous subarachnoid haemorrhagic patients. There is no difference between CTA and DSA considering the size of the aneurysm and the neck diameter of aneurysm. Regarding location of aneurysm no difference is reported by comparing CTA and DSA. A large scale multi-centre study should be carried out.

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